Electromagnetic Theory II: Homework 16

Due: 6 April 2021

1 Griffiths, *Introduction to Electrodynamics, 4ed*, 10.12, page 448.

2 Fields produced by an infinite straight wire

An infinite straight wire carries a current

$$I = I_0 t/\tau$$

for $t > 0$ and where I_0 is a constant with units of current and τ is a constant with units of time.

a) Consider a point a distance s from the wire. Show that the potentials are

$$V = 0$$
$$\mathbf{A} = 0$$

for $t < s/c$ and

$$V = 0$$
$$\mathbf{A} = \frac{\mu_0 I_0}{2\pi\tau}\left[t \ln\left(\frac{ct + \sqrt{c^2t^2 - s^2}}{s}\right) - \frac{\sqrt{c^2t^2 - s^2}}{c}\right]\hat{\mathbf{z}}$$

for $t \geqslant s/c$.

b) Determine the electric and magnetic field produced by the current for $t \geqslant s/c$. Use cylindrical coordinates.

c) Determine the Poynting vector associated with these fields. In which direction is energy transported? At what speed is it transported?